ERIC Document Resume	See Instruction Sheet	DATE OF RESUME 8/4/65	DATE RECEIVED

A. PUBLICATION DATA

1. ERIC NUMBER	2. ORIGINATOR CONTROL NO(S).	3. IDENTIFICATION NO.
ED000386	7138	N.A.

DO NOT WRITE IN SPACE BELOW

4. AUTHOR(S):
Thistlethwaite, Donald L.

5. TITLE OF DOCUMENT ABSTRACTED:
Social Characteristics of Universities and Colleges in Relation to their Intellectual Output

6. PUBLICATION TITLE:
N.A.

7. EDITOR(S):
N.A.

9. PUBLISHER OR SOURCE
National Merit Scholarship Corporation

8. PLACE OF ORIGIN
ORG. National Merit Scholarship Corp.
ST. 1580 Sherman Avenue
CITY, STATE Evanston, Illinois
TELE. EXT.
INST/LOC CODE

10. VOL.	11. PAGES	12. MO./YR.	13. TOTAL PP.
N.A.	N.A.	59	14

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TYPE OF REPORT
PROPOSAL ☐
IN-PROGRESS ☐
FINAL ☒
FOLLOW-UP ☐

OTHER ERIC REFERENCES:

ERIC SATELLITE CODE

B. INDEXING DATA

14. SUBJECT AREA

15. TYPE OF ENDEAVOR
experimental study

16. INDEXING TERMS (6-12)

experimental studies G-23		environment G-17		student-Teacher Relations Y-15A	
students Y-15		talent Y-19		effectiveness G-12	
graduates S-05		teachers Y-21			

17. ABSTRACT (MAX. 280 WORDS)

Reports a study that represents an extension of work on this subject begun several years ago by R. H. Knapp and his associates at Wesleyan University. The earlier studies strongly suggested that certain colleges and universities are more productive of scientists and scholars than others. Since they did not make adjustments for the fact that some colleges enroll a higher proportion of talented students than others, the results fail to indicate whether the alumni of some colleges exhibit more achievement because of their college experiences or because of their initial superiority in aptitude. Thistlethwaite's study attempts to resolve this ambiguity by developing an index of college productivity that is independent of student quality. In general, the results suggest that student and faculty cultures, and certain qualities of the interactions between students and faculty, are probably more potent determinants of the college's effectiveness than are the college's geographical, religious, and organizational characteristics emphasized in the earlier studies.

ERIC No.

18. SOURCE OF ABSTRACT

C. FUNDING DATA

19. SUPPORTING ORGANIZATION	20. DIVISION OR DEPT.	21. CONTRACT NO. / PROJECT NO.
	22. TOTAL COST OF PROJECT	
	23. DURATION OR PROJECT	U.S. Department of Health, Education, and Welfare Office of Education

ERIC Form 1

IV-9

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education

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p.19-R4

SOCIAL CHARACTERISTICS OF UNIVERSITIES AND COLLEGES IN RELATION TO THEIR INTELLECTUAL OUTPUT[1]

Donald L. Thistlethwaite

National Merit Scholarship Corporation

Nations, governments, universities, high schools, and even elementary schools increasingly find themselves participating in the drive to develop scientific talent. The scientific events of 1957 served to dramatize the penetration of science into politics, and has made clear that the development of intellectual talent is a national as well as a local concern. As a result, we are witnessing a ground swell in research activity on ways in which we may improve the recruiting and training of exceptional talent.

The National Merit Scholarship program offers an unusual opportunity for studying the development of intellectual talent. The number of high school students participating in this nationwide talent search reached almost a half a million in 1959. We identify each year a population comparable to Terman's "gifted children," since the aptitude test scores of students winning scholarships place the bulk of them in the highest two per cent of the nation's school population. We are naturally interested in learning what are some of the factors that influence their later achievement.

The study on which I shall report is an extension of the work begun by R. H. Knapp and his associates at Wesleyan University several years ago.[2] You will recall that these studies strongly suggested that certain colleges and universities are more productive of scientists and scholars than others. However, since Knapp and his colleagues did not make adjustments for the fact that some colleges enroll a higher proportion of talented students than others, their results do not tell us whether the alumni of some colleges exhibit more achievement because of their college experiences or because of their initial superiority in aptitude. The study I shall report attempted to resolve this ambiguity by developing an index of college productivity that was independent of student quality. In general, the results suggest that student and faculty cultures, and certain qualities of the interactions between students and faculty are probably more potent determinants of the college's effectiveness than are the college's geographical, religious, and organizational characteristics which Knapp and his colleagues have emphasized.

Because of the reluctance of many colleges to release aptitude data on their entering classes, it has been difficult to make the required adjustments. Our approach was to develop an approximate index of student quality and to validate

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[1] Paper prepared for the Fourth World Congress of Sociology, Milan and Stresa Italy, September, 1959.

[2] R.H. Knapp and H.B. Goodrich, Origins of American Scientists, (Univ. of Chicago Press, Chicago, Illinois, 1952); R.H. Knapp and J.J. Greenbaum, The Younger American Scholar: His Collegiate Origins, (Univ. of Chicago Press, Chicago, Illinois, 1953).

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it for those colleges on which we could obtain aptitude data If the index is valid for these colleges it may be used to describe other colleges as well. The first two National Merit programs provided records of the college enrollments of over 9,600 talented students. For each of 511 colleges we calculated the percentage of the freshmen class who were Merit Scholars or Certificate of Merit winners in the Merit program during the preceding Spring. This percentage for 1956 freshman enrollments is referred to as the 1956 Talent Supply Index. For 39 men's colleges the correlation between this index and the mean Scholastic Aptitude Test score of entering 1956 classes was .74, and for 43 women's colleges the correlation was .76. These estimates of validity are probably conservative, since these colleges were all College Board colleges, and so tended to enroll superior students. The Talent Supply Index probably has a validity of at least .80 for the wider range of talent. To increase the reliability of this measure of student quality, the two talent supply indexes for the years 1956 and 1957 were added.[3]

Our method of computing productivity indexes for each of the 511 colleges is based upon the assumptions that (a) the quality of the college's incoming class tends to be stable over a period of years, and (b) that the Talent Supply Index (i.e., the per cent of the college's opening enrollment in 1956 and 1957 who were finalists in the Merit program) is a reasonably accurate measure of the college's talent supply. Figure 1 illustrates the method. Our natural science productivity index is defined as the discrepancy between a college's expected rate of producing natural science Ph.D.'s (as predicted from its enrollment of talented students) and its actual rate of productivity. In Figure 1, A and B represent two colleges with similar talent supplies. The predicted rate of Ph.D. productivity for both colleges is Yo, and the actual rates are Ya and Yb. The residual -- or discrepancy between obtained and predicted rates -- for college A is Yo minus Ya, while the residual for college B is Yo minus Yb. The residuals thus yield an index of productivity independent of student quality. Computations were actually slightly more complex: a constant was added to make all residuals positive; also the regression analysis was performed on logarithms of the percentages, since both the rates of producing Ph.D.'s and the rates of enrolling Merit finalists were highly skewed.

Since our analysis suggested the need to treat scholarly and scientific fields separately, we have developed two productivity measures -- one for the natural sciences and one for the arts, humanities and social sciences. To save time, I shall refer to the former as the NS and the latter as the AHSS index. The records of doctorates granted which we used were those published by the

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[3] The correlation between the two indexes for the 511 colleges was .92, indicating a fair degree of stability in talent supply. The correlation between mean ACE scores of entering freshmen at 19 Minnesota institutions of higher learning, over the seven year period 1947-1954, was .80 (data from personal communication, W. R. Layton, University of Minnesota).

National Academy of Sciences -- National Research Council,[4] and cover the years 1950-56. Since the median lapse between the baccalaureate and the science doctoral degrees is about seven years, we are dealing with alumni who graduated from college during the period 1943-49. Thus in using our talent supply index we are extrapolating backwards over a ten to fifteen year period.

Because of the extrapolations used, the measures are not reliable enough to permit us to compare individual colleges. However, several lines of evidence suggest the indexes are sufficiently valid for group comparisons. First, according to students' reports, there is a clear difference between productive and unproductive colleges in their emphasis upon preparing for graduate study. Secondly, the measures seem to be sensitive to differences in college objectives. As expected, professional and technical schools rank highest in NS productivity and lowest in AHSS productivity. Similarly, of students attending colleges ranking high in AHSS productivity, 96 per cent report that the college "library is exceptionally well equipped with journals, periodicals, and books in the social sciences." Of students attending colleges ranking low in AHSS productivity, only about 60 per cent endorse this statement. Thirdly, colleges located in the South tend to rank low on both measures, a finding which is consistent with the Knapp-Greenbaum results.

I shall present first the analysis for the 511 colleges, which relates student achievement to organizational and geographic characteristics of the college. A second set of results, involving descriptions of environmental pressures and demands at 36 selected colleges, is discussed in later sections.

Table 1 compares the extent to which different types of institutions stimulate their undergraduate students to seek the Ph.D. Differences between the mean productivity indexes of different types of undergraduate programs are statistically significant for both NS and AHSS measures.

Cultural values and norms which discourage women from seeking the Ph.D. may account for the relatively poor showing of women's colleges and universities. The specialized character of the curriculum and student goals at professional and technical schools (such as the California Institute of Technology) is reflected

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[4] The Baccalaureate Origins of Science Doctorates Awarded in the United States, 1936-1950, Office of Scientific Personnel, National Academy of Sciences--National Research Council, Publ. No. 382 (Washington, D.C., 1955); Baccalaureate Origins of Doctorates in the Arts, Humanities, and Social Sciences Awarded in the United States, 1936-1950, Office of Scientific Personnel, National Academy of Sciences--National Research Council, Publ. No. 460 (Washington, D.C., 1956); Doctorate Production in United States Universities, 1936-1956, Office of Scientific Personnel, National Academy of Sciences--National Research Council, Publ. No. 585 (Washington, D.C., 1958). The classification of disciplines described in the last-mentioned publication was used in the present study to obtain separate indexes for productivity in the natural sciences and in the arts, humanities, and social sciences--that is, anthropology, sociology, geography, and psychology are included within the social sciences.

in the fact that these schools rank highest in NS productivity and lowest -- even below women's colleges and universities -- in AHSS productivity. Men's colleges and universities, which have the advantage of a student clientele for whom graduate study is culturally approv[illegible] rank relatively high on both measures. In view of their coeducational student bodies, publicly supported universities are outstandingly productive of Ph.D.'s in the natural sciences.

Colleges with Protestant religious affiliations are significantly more productive than Catholic colleges (Table 2). At the same time it should be pointed out that colleges without any religious affiliations do not differ in productivity from Protestant colleges. Hence the difference between Catholic and Protestant colleges probably should not be attributed to the motivating effects of the Protestant ethic, but rather to factors indigenous to the Catholic college or its student body. These differences might be due to teaching practices, parental values, or the initial goals of the students.

Geographical location is related to productivity in the sense that colleges in the southern states rank lowest on both the NS and AHSS measures. However, there are only negligible differences in college productivity between the remaining four geographical regions (Table 3). These results in part confirm the Knapp-Greenbaum findings, but do not support the Knapp-Goodrich results for 50 colleges which, in a special analysis, were adjusted for differences in student quality. The latter results indicated that the Middle and Far West ranked highest, the South intermediate, and the Middle Atlantic and New England regions ranked lowest in science productivity. The small number of colleges, however, makes these results unreliable.

On the whole, the point biserial correlations shown in Table 4 indicate that the organizational and structural characteristics of the college are not highly predictive of the college's productivity. Cost of attendance, which Knapp and Goodrich found to be related to productivity, has zero-order correlations with our indexes. The highest correlation, .29, is between NS productivity and number of volumes in the library. A much clearer picture of the college environments emerges when we consider the faculty and student pressures associated with productivity.

To obtain estimates of the role played by social influences in student achievement we made one further assumption: we assumed that the environmental demands and pressures at colleges in our sample have not varied greatly during the past 10-15 years. With this premise, it is possible to use current appraisals of the college environment as an estimate of the college atmosphere during the period in which our alumni groups were in college.

The Pace and Stern College Characteristics Index[5] was administered to 916 of our National Merit Scholarship winners and near-winners at 36 colleges. Only

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[5] C.R. Pace and G.G. Stern, College characteristics index (Form 458) (Authors, Syracuse, N.Y., 1958); C.R. Pace and G.G. Stern, An approach to the measurement of psychological characteristics of college environments. J. educ. Psychol., 49, 269-277 (1958).

those colleges which enrolled a sufficient number of Merit finalists were included; as a result we are dealing with a group of colleges popular among talented students and ranking relatively high on our Talent Supply Index. The students, who had completed a year and a half of college at the time of the survey, were asked to indicate whether each of the 300 statements in the CCI was probably true or probably false about their college. Representative items appearing in the CCI are given in Table 5. In writing items for the CCI scales Pace and Stern say they tried to think of items which would reveal the characteristic demands or pressures of the college environment.

The average number of observers per college was only 25, and these observer groups can hardly be thought of as representative samples since they come from an exceptionally talented group. On the other hand, if a dominant social or value system really exists in a particular college, almost any group of students attending that college will probably recognize it. Fortunately, we found abundant evidence for the existance of diverse college cultures among the 36 schools. Equally important, the results reflected differences in college atmospheres which are consistent with common belief. For example, Harvard and Radcliffe had the highest median scores on Humanism; Massachusetts Institute of Technology the highest on Scientism; Georgia Institute of Technology and Rensselaer Polytechnic Institute the highest on Pragmatism; Smith College the highest on Nurturance; and the University of Chicago the highest on Understanding.

The correlations shown in Table 5 were obtained by correlating the college's median score on each CCI scale with its productivity indexes. Only the results for scales having a correlation significant at the .01 level with at least one of the productivity measures are shown. The most striking feature of these results is that one type of college environment is associated with achievement in the natural sciences and another kind with accomplishment in the arts, humanities, and social sciences. Unfortunately, the CCI scales are composites of items descriptive of students and faculty. The Humanism scale, for example, contains 5 items describing students and 5 items describing the faculty. From these correlations we cannot tell whether faculty influences or student culture influences or both are related to productivity.

A further analysis was therefore undertaken based upon scales revised to include more homogeneous items. A set of student press scales, containing only items descriptive of students, and a second set of faculty press scales, containing only items descriptive of the faculty and administration, were developed. Since items which showed no relation to the productivity indexes were eliminated, the revised scales need to be cross-validated before we can be sure they predict productivity as efficiently as they seem to.

The results suggest that both student peer groups and faculty behaviors and values are determinants of student achievement.

Table 6 shows the student attitudes, interests, and peer group norms which are related to achievement. In general, this analysis is consistent with the hypothesis that scientific achievers thrive in a different kind of environment than

do scholarly achievers. Student cultures characterized by Humanism, Breadth of Interests, and Reflectiveness are associated with scholarly productivity, and cultures characterized by Participation and Aggression are negatively related to it. Natural science productivity, on the other hand, is associated with student cultures which stress Scientism and Aggression; it does not appear in colleges where student cultures stress Social Conformity. It could be, of course, that initial differences in student values are partly reflected in these correlations. However, it seems reasonable to assume that different student cultures have effects upon student achievement because of the kinds of behavior they sanction.

The results of greatest interest to the educator are, of course, those relating faculty behaviors to student achievement. This analysis, shown in Table 7, once again confirms the view that one type of college press stimulates achievement in the natural sciences while a different type facilitates achievement in the arts, humanities, and social sciences. The only faculty press scale significantly related in the same direction to both types of productivity is the scale called Informality and Warmth of Student-Faculty Contacts. Colleges which are successful in encouraging scholarly achievement are characterized by (a) excellent social science faculty and resources, (b) a flexible, or somewhat unstructured, curriculum, and (c) energy and controversiality of instruction. On the other hand, colleges high in NS productivity are characterized by the absence of outstanding social science faculty and resources and of close supervision. Further, the teachers who stimulate scientists tend to be nondirective in their teaching methods.

One additional analysis, which I have summarized in Table 8, relates college press to hours of study. We do not consider the number of hours the student spends in study a measure of achievement, but one would generally expect to find students in stimulating college environments spending more time in study. As a part of a related project we asked some 1,900 near-winners in our program, who were attending 35 of the 36 colleges on which we had CCI data, to estimate the average number of hours per week they spent in study outside the classroom. Analysis of variance indicates that there are highly significant differences in mean hours of study at the 35 colleges. Oddly enough the amount of study reported by the college's students was related to AHSS productivity but not to NS productivity (correlations were +.48 and -.01, respectively). Perhaps students in the natural sciences do their most productive study in the laboratory, and do not count this as study spent "outside the classroom." In any case, there is a striking similarity between the college press correlates of the AHSS and the hours of study measures. Each of the student press scales significantly related to mean hours of study, is also related to AHSS productivity. A similar statement holds for faculty press scales, with the exception of the scale called "emphasis upon high academic standards."

Some of the correlations summarized here, to be sure, reflect a specialization of function in American colleges. This seems particularly true, for example, of the scale rating the excellence of social science faculty and resources. Other scale correlations, however, suggest that pressures and demands, which are not the result of deliberate planning, frequently affect the student's motivation to seek advanced training. For example, it is doubtful that any of the last five

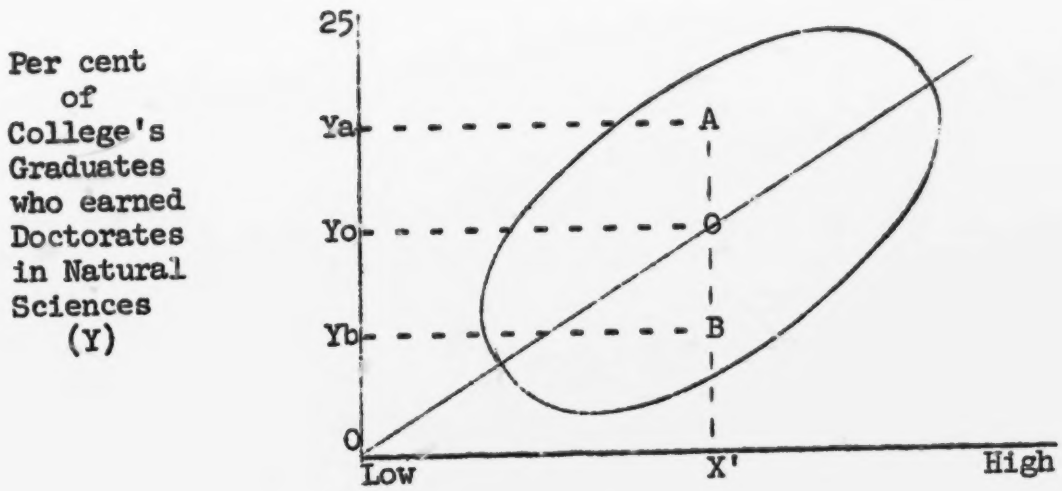
faculty traits listed in Table 7 represent behaviors calculated to stimulate graduate study, yet each is significantly related to the college's productivity.

The assumptions on which these results are based are too tenuous to identify very clearly the college cultures which stimulate student achievement. Yet these preliminary results convince us that social systems at colleges and universities are important determinants of the extent to which promising young scholars and scientists realize their potentialities.

Especially promising from the standpoint of finding ways to stimulate promising young scholars and scientists are studies of the effects of faculty behavior at the graduate school level. If we can find such high co-variation of achievement with measures of the undergraduate environment, what might we find at the graduate level where faculties are primarily concerned with developing research talent! Graduate faculties are particularly suited for investigations of the positive and negative effects upon productivity of different teaching methods, tutorial approaches, and ways of assessing thesis work. Further, since colleges and universities produce research as well as researchers, efforts should be made to determine what kinds of administrative and departmental organizations are favorable to faculty creativity and productivity.

Figure 1

Method of Calculating Productivity Index for Natural Sciences



Given the correlation table relating X and Y, the residuals in predicting Y from X give an index of productivity independent of student quality. Assume two colleges, A and B, with identical talent supplies (X'). College A is highly productive since its actual productivity (Ya) is high relative to the predicted rate (Yo); college B is very unproductive since its rate (Yb) is low relative to the predicted rate.

Table 1

Ph.D. Productivity of Undergraduate Programs by Type of Institution

Type of Institution#	Number of institutions	Adjusted Productivity Index			
		NS		AHSS	
		Mean*	S.D.	Mean*	S.D.
Professional or technical schools	28	173 (1)	28.7	214 (7)	18.3
Men's colleges and universities	52	181 (2)	24.2	164 (3)	27.2
Women's colleges and universities	66	236 (7)	20.2	199 (6)	24.0
Coeducational institutions					
Private colleges	155	194 (4)	26.6	161 (1)	26.9
Public colleges	63	206 (6)	29.0	164 (2)	30.3
Private universities	64	197 (5)	19.2	170 (4)	24.8
Public universities	80	183 (3)	18.2	175 (5)	17.1
	508				
F-ratio		43.5		32.4	
Probability		<.01		<.01	

Three institutions were unclassified.

* In this table, and those which follow, a numerically low index indicates high productivity. Numbers in parentheses are ranks based upon mean productivity indexes.

Table 2

Ph.D. Productivity of Institutions with Different Types of Religious Affiliation

Type of Affiliation	Number of institutions	Adjusted Productivity Index			
		NS		AHSS	
		Mean	S.D.	Mean	S.D.
Catholic	81	209	32.9	189	26.5
Protestant	157	198	29.0	163	28.5
Difference		11		26	
Probability		<.02		<.01	

Table 3

Ph.D. Productivity of Institutions Classified by Geographical Position

Geographical Position*	Number of institutions	Adjusted Productivity Index NS Mean	NS S.D.	AHSS Mean	AHSS S.D.
New England	32	191 (1)	28.5	171 (2)	25.5
Atlantic Seaboard	117	196 (4)	32.5	174 (3)	32.0
Middle West	185	195 (3)	27.3	167 (1)	28.6
Far West	65	191 (2)	31.6	175 (4)	29.8
South	111	210 (5)	27.2	182 (5)	27.4
	510				
F-ratio		6.36		5.18	
Probability		<.01		<.01	

* One institution (University of Puerto Rico) was not classified. The geographical classification described by Knapp and Goodrich was used in this analysis.

Table 4

Ph.D. Productivity and College Characteristics

Characteristic#	Number of institutions	Correlation with adjusted productivity index NS	AHSS
Type of student body (coed.)	511	.21*	.26*
Number of volumes in library	488	.29*	.11*
Size of 1956 freshman class	511	.22*	-.04
Size of city	510	-.06	-.18*
Student-faculty ratio	498	.05	.12*
Level of training offered (Ph.D.)	511	.13*	-.04
Religious affiliation	511	-.12*	.04
Type of control (public)	511	.11*	-.03
Cost	511	-.04	.05

\# The number of institutions vary because of incomplete data in the sources used for classification. Characteristics in parentheses indicate qualities weighted positively in computing point-biserial correlations. Signs of residuals have been reflected so that positive correlations indicate the characteristics associated with greater productivity.

* P <.01

Table 5

Correlations Between College Characteristics Index Scales and Productivity at 36 Colleges ‡

CCI Scale	Most discriminating item on scale	Correlation with productivity in # NS	AHSS
Humanism	Few students are planning post-graduate work in the social sciences. (F)	-.23	.85
Pragmatism	Students are more interested in specialization than in liberal education. (T)	.15	-.77
Reflectiveness	Modern art and music get little attention here. (F)	-.20	.69
Sentience	Student rooms are more likely to be decorated with pennants and pin-ups than with paintings, carvings, mobiles, fabrics, etc. (F)	-.35*	.68
Harmavoidance	Fire drills are held in student dormitories and residences. (T)	-.23	.51
Deference	Religious worship here stresses service to God and obedience to His laws. (T)	-.38*	-.50
Abasement	There is a lot of apple-polishing around here. (T)	-.11	-.47
Understanding	There is a lot of emphasis on preparing for graduate work. (T)	.18	.43
Scientism	Few students are planning careers in science. (F)	.59	-.03
Aggression-Blameavoidance	Students ask permission before deviating from common policies or practices. (F)	.56	-.24
Impulsion-Deliberation	Students frequently do things on the spur of the moment. (T)	.43	.03
Order	Professors usually take attendance in class. (T)	-.43	-.18

‡ The 36 colleges were: Amherst, Brown (including Pembroke), California Institute of Technology, Carleton, Carnegie, U. of Chicago, U. of Colorado, Cornell, Dartmouth, Duke, Georgia Institute of Technology, Harvard, Indiana, Iowa State, U. of Kansas, Massachusetts Institute of Technology, U. of Michigan, U. of Minnesota, Northwestern, U. of Notre Dame, Oberlin, U. of Pennsylvania, Pomona, Princeton, Purdue, Radcliffe, Rensselaer Polytechnic Institute, Rice, Smith, Stanford, Swarthmore, U. of Texas, U. of Wisconsin, Wellesley, Wesleyan, and Yale.

\# In this table, and in succeeding tables, coefficients significant at the .01 level have been surrounded by rectangles; coefficients significant at the .05 level are indicated by asterisks.

Table 6

Correlations Between Revised Student Press Scales and Productivity at 36 Colleges

Student Press scale	Most representative item (highest item-total score correlation)	Correlation with productivity in NS	AHSS
Humanism	There is a lot of interest here in poetry, music, painting, sculpture, architecture, etc. (T)	-.07	.71
Breadth of Interests	Most students have very little interest in round tables, panel meetings, or other formal discussions. (F)	-.27	.67
Reflectiveness	There would be a capacity audience for a lecture by an outstanding philosopher or theologian. (T)	-.05	.67
Participation	Student pep rallies, parades, dances, carnivals or demonstrations occur very rarely. (F)	.00	-.53
Aggression	Hazing, teasing and practical joking are fairly common. (T)	.43	-.54
Scientism	When students get together they seldom talk about science. (F)	.59	.03
Social Conformity	Students think about dressing appropriately and interestingly for different occasions--classes, social events, sports, and other affairs. (T)	-.42*	.03

Table 7

Correlations Between Revised Faculty Press Scales and Productivity at 36 Colleges

Faculty press scale	Most representative item (highest item-total score correlation)	Correlation with productivity in NS	Correlation with productivity in AHSS
Excellence of social science faculty and resources	Course offerings and faculty in the social sciences are outstanding. (T)	-.42*	.83
Flexibility of curriculum	If a student fails a course he can usually substitute another one for it rather than take it over. (T)	-.31	.68
Energy and controversiality of instruction	Class discussions are typically vigorous and intense. (T)	-.13	.58
Informality and warmth of student-faculty contacts	Faculty members and administrators see students only during scheduled office hours or by appointment. (F)	.43	.40*
Closeness of supervision	Professors usually take attendance in class. (T)	-.38*	-.22
Directiveness of teaching methods	Instructors clearly explain the goals and purposes of their courses. (T)	-.42*	.24

Table 8

Correlations Between Revised Press Scales
and Hours of Study

College Press	Correlation with mean hours of study
I. Student Culture:	
Reflectiveness	.54
Humanism	.47
Breadth of Interests	.43
Participation	-.42*
Aggression	.24
Scientism	.20
Social Conformity	-.14
II. Faculty Press:	
Flexibility of curriculum	.77
Energy and Controversiality of Instruction	.56
Emphasis Upon High Academic Standards	.53
Excellence of Social Science Faculty and Resources	.42*
Informality and Warmth of Student-Faculty Contacts	.38*
Closeness of Supervision	-.32
Directiveness of Teaching Methods	.29